

# NREN Status

October 6, 1999

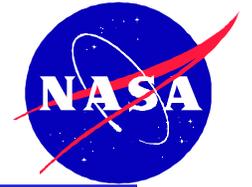
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# Agenda



- Budget
- Milestones
- Applications Highlights
- Network Testbed Highlights
- Research Collaboration
- Technology Transfer

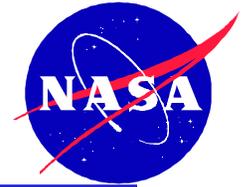
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# Budget



- NASA allocated 10M annually for 3 years
  - No new money
  - Programs other than NREN
- NREN's specific allocation:
  - 10M      FY98
  - 7M        FY99
  - 8M        FY00





# Milestones



		FY00	FY01	FY02	FY03	FY04
<b>BASELINING</b>		3/00 Identify NASA's current capability in WAN technology				
<b>PERFORMANCE</b>						
	Performance	6/00 Develop QoS-based measurement mechanisms 9/00 establish gigabit capability in WAN testbed			9/03 develop tools to embed adaptive networking learning within advance applications	
	Interoperability	3/00 infuse multicast capabilities across multiple NGI testbeds	9/01 infuse QoS capabilities across multiple NGI testbeds	9/02 infuse traffic engineering capabilities across multiple NGI testbeds		
	Portability					
	Reliability					
	Resource Management	6/00 establish QoS networking capabilities in WAN testbed	9/01 establish traffic engineering networking capabilities in WAN testbed			
<b>DEMONSTRATION</b>						
	Application #1	Infusing Multicast Technology	Gigabit WAN capabilities	Gigabit to the desktop	Network adaptive applications	
	Application #2	Infusing QoS Technology	QoS interoperability	Traffic Engineering capability	X times performance	
	Application #3	Hybrid networking enhanced performance				
<b>CUSTOMER USE</b>		6/00 infuse multicast technology in NASA's operational WAN	9/01 infuse QoS technology in NASA's operational WAN	9/02 infuse Traffic Engineering technology in NASA's operational WAN		9/04 transfer NGI technologies to NASA's operational WAN

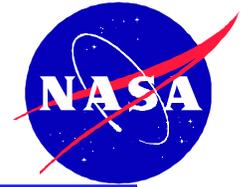
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# Application Highlights



- Digital Earth / Mars / Sky
- Information Power Grid
- Trans-Pacific Experiments
- Virtual Collaborative Clinic
- Video Streaming

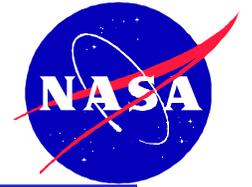
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# Application Highlights



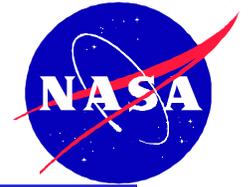
## Digital Earth/Mars/Sky

- NASA Earth and Space Science Enterprises goal is "human telepresence" throughout the earth and solar systems
- Requires high performance remote access and visualization for very large earth and space data sets in the US and worldwide
- Examples:
  - American Museum of Natural History "earth wall" and "sky dome" driven by data from current and recent NASA missions
  - Proposed Mars Terrain Distributed Testbed, Mars 2003 mission visualization prototyping (NASA JPL, NASA Ames)

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# Application Highlights

## Information Power Grid (IPG)

- The IPG goal is to bring together heterogeneous, distributed, compute, storage, network and experimental resources as an intelligent system.
- Network Requirements
  - Bandwidth: 30 Mbps - 100 Mbps
  - Quality of Service (Bandwidth Reservation)
- Partnerships: Department of Energy
  - Argonne National Lab (ANL)
  - Lawrence Berkely National Lab (LBNL)





# Application Highlights

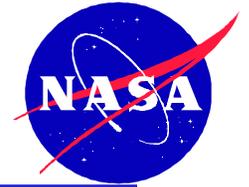
## Trans-Pacific Experiments

- Goal is to demonstrate feasibility and usefulness of high performance episodic events using satellite technologies for global reach
  - Remote observational astronomy (Japanese scientists and high school, in cooperation with JPL and Mount Wilson Observatory)
  - Visible human digital library (interactive access by Japanese university researchers to NLM visible human digital model)
- Network Requirements
  - Multicast, Multiple Satellite Hops, International Connectivity
- Partners
  - NIH (NLM), vBNS+, CA\*net (Canada), Intelsat, APAN

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# Application Highlights

## Virtual Collaborative Clinic (VCC)

- The goal of the Virtual Collaborative Clinic is to demonstrate a high performance testbed, which allows colleagues in the medical arena to simultaneously review medical images remotely in real time.
- Network Requirements
  - Bandwidth: 30 Mbps - 50 Mbps
  - Multicast
- Partnerships:
  - Navajo Nation (New Mexico)
  - Abilene & vBNS
  - NASA Ames & NASA Glenn
  - CALREN2 GigaPOP
  - Stanford University & U.C. Santa Cruz

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# Application Highlights

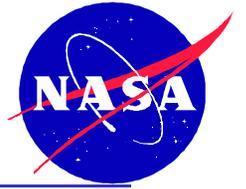
## Video Streaming

- **Primary Goals**
  - Greater flexibility for scene selection & viewing
  - User interface that permits intuitive selection of a broader set of cameras than the current mechanisms
  - Decreased cost/complexity over dedicated or leased video circuits
  - A network that permits improved image quality without complex re-engineering
- **Network Requirements**
  - Bandwidth: 20 Mbps - 40 Mbps
  - Multicast





# Network Testbed Highlights



- Quality of Service
- Gigabit Networking
- Measurements
- Next Generation Internet Exchanges

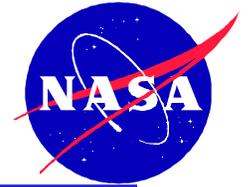
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# Network Testbed Highlights



## Quality of Service

- Goals
  - Guaranteed network resource reservation for NASA Applications
    - Bandwidth
    - Latency
    - Error Rate
- Applications
  - Information Power Grid
  - Video Streaming
- Partners
  - Internet 2 QBone
  - Department of Energy

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# Network Testbed Highlights



## Gigabit Networking

- Planned OC-48 Connections
  - NASA Ames, NASA GSFC & JPL
  - Interconnection to NTON
  - Interconnection to ATDnet
- Applications
  - Digital Earth / Mars / Sky
- Workshop Planned in August 2000

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# Network Testbed Highlights



## Measurement

- Goal: Integrate and deploy a set of hardware & software tools to support
  - Analysis of IP packet flows (especially for preferred flows [QoS])
  - Performance characterization of specific network elements, technologies
- Methodologies
  - Passive & Active techniques
  - Incorporate core measurements and end-to-end measurements
  - Support unicast and multicast flows
- Architecture Elements
  - Data collection (distributed network probes, end stations)
  - Data archiving, selection, graphical display (web-based mechanisms for distributed clients)

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# Network Testbed Highlights

## Next Generation Internet Exchanges

- **NGIX-SF**
  - NGI West Coast Peering Point
  - Current Peering Partners: Abilene, DREN, NREN
  - ATM Infrastructure: OC-3 / OC-12
  - First Demonstrations: GOIN'99
    - NASA, DREN, Abilene, vBNS, NOAA
- **Multicast Internet Exchange (MIX)**
  - First operational Multicast Internet eXchange
  - Currently 10 peering networks – 3 federal, 7 commercial
  - Protocols and Implementation
    - Native IP Multicast
    - Second Generation Protocols
  - FY' 2000 Goals: new switch installation, additional peerings, Abilene connectivity

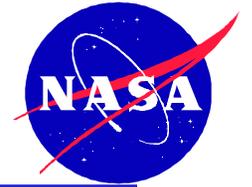
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# Research Collaboration



- NGI Agencies
- Internet 2
- Academic Grants
- Workshops
- GOIN'99

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# Research Collaboration



## NGI Agencies

- Department of Energy
  - Quality of Service (ANL, LBNL, SNL)
- National Institute of Health
  - Trans-Pacific Experiments (NLM)
- DARPA
  - Gigabit Networking (NTON, HSCC)
- Department of Defense
  - GOIN'99

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# Research Collaboration

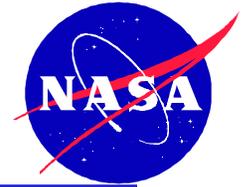
## Internet 2

- Peering
  - vBNS & Abilene
- Technology
  - Multicast: Stanford, Univ. Cal., CALREN2, Internet 2 Multicast Working Group
  - Quality of Service: Internet 2 Qbone, UIUC
- Applications
  - Virtual Collaborative Clinic: Stanford, U.C Santa Cruz
  - Astrobiology: University of West Florida





# Research Collaboration



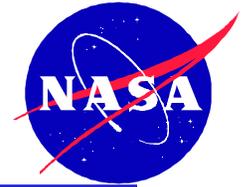
## Academic Grants

- Georgia Tech
  - Technology focus QoS; development of new algorithms to achieve QoS over hybrid networks
- University of Illinois, Urbana-Champaign
  - Technology focus End-to-end application QoS; development of an effective interface to translate application QoS requirements into requirements for using both computer and network resources, thus achieving end-to-end QoS
- University of California, Davis
  - Technology focus security; analysis of causes for denial of service in a network infrastructure and development of solutions to address the problem





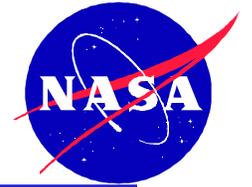
# Research Collaboration



## Academic Grants

- **UCLA**
  - Technology focus QoS; QoS routing, development of congestion-control algorithms, comparison of IP over ATM versus IP over SONET
- **Naval Postgraduate School**
  - Technology focus policy management; development of a prototype server for centralized management of diverse network policies





# Research Collaboration

## Academic Grants

- **University of West Florida**
  - Technology focus human and machine cognition; development of concept maps as a model for understanding, explaining, and organizing new domains of knowledge for collaborative use over the Internet; development addresses Mars data and Astrobiology specifically
- **Tennessee State University**
  - Technology focus QoS; comparison of various types of networks to support the transfer of large data files to support Space Science applications





# Research Collaboration



## Workshops

- **Bridging the Gap Workshop**
  - Was held August 10-11, 1999, at NASA Ames Conference Center
  - Cosponsored by NRT and HPNAT
  - Attended by over 100 NGI technologists, applications, agency people
- **“OC-48” Workshop**
  - Planned for August 14-17, 1999, at NASA Ames Conference Center
  - Will bring together over 100 NGI networkers and applications people and "OC-48" industry representatives
  - Aimed at providing status, lessons learned, and creating consensus on how NGI networkers and applications people should prototype and deploy real "gigabit-to-the-desktop" applications
  - Three themes: Network, Desktop, Applications

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# Research Collaboration



## Global Observation Information Network (GOIN)

- **Description:**

- US-Japan bilateral initiative agreed at 1994 Clinton-Miyazawa summit
- US side: program lead by NOAA, technical lead by NASA, with USGS

- **Goal**

- Demonstrate effective bilateral agency working using space-based and earth-based observations to collaborate on global problems
- Prototype "information network" of persistent global observation data in support of grass roots regional earth science activities

- **Achievement**

- Established largest ever peering of multiple agency and national high performance research and education networks (HPRENs) via STAR TAP and NGIX-SF
- Connected five of the six NGI "JETnets", as well as, the Asia-Pacific Advanced Network (APAN)

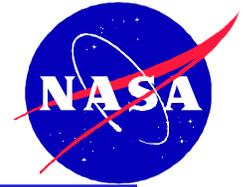
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# Technology Transfer



- **Within NASA**
  - Application transition
  - Technology transition
- **Inter-Agency**
  - Multicast technology
- **Reach**
  - Virtual Collaborative Clinic; joint effort between NASA/GRC and Navajo Nation to establish hybrid solution in Shiprock, New Mexico.
  - Over Horizon; joint effort between HPCC/Learning Technology, NSF, and NASA/GRC to establish hybrid solutions in areas such as the Four Corners Area.

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